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(12) UK Patent Application (19) GB (11) 2 290 005 (13) A

(43) Date of A Publication 06.12.1995

(21) Application No 9410806.5

(22) Date of Filing 28.05.1994

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(51) INT CL^6
H04Q 7/22

(52) UK CL (Edition N)
H4L LDSX L1H10

(56) Documents Cited
GB 2262683 A **EP 0332825 A2**

(58) Field of Search
UK CL (Edition M) **H4K KY4D14P , H4L LDLX LDSX LECX**
INT CL^5 **H04M 1/72 , H04Q 7/00 7/02 7/04**
Online databases:WPI

(54) Communications system

(57) An apparatus and method are provided for outputting DTMF tones at a separate output 25 from the audio output 14 of a mobile station MS operating in a communications system where DTMF tones are transmitted from time to time from a base station BSS to the mobile station. A further embodiment is described (Fig. 5) using out of band signalling for the DTMF tones. The method is further described by means of flow charts (Figs. 6 and 7).

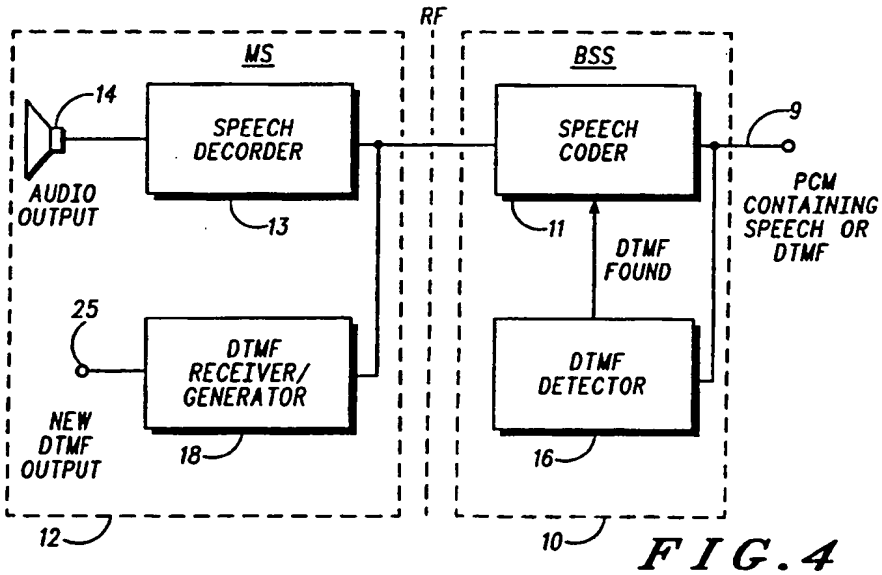
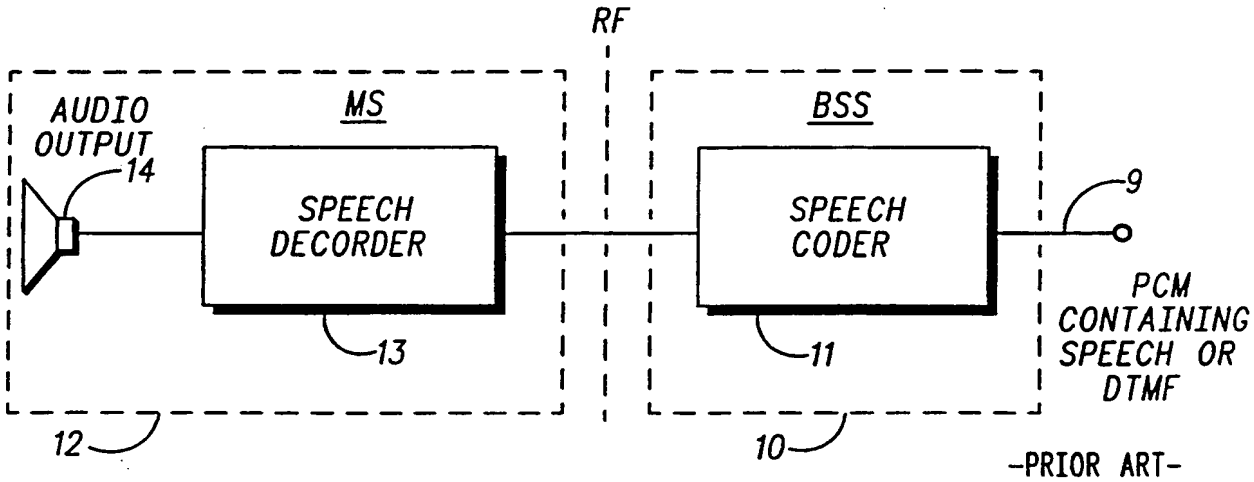


FIG. 4

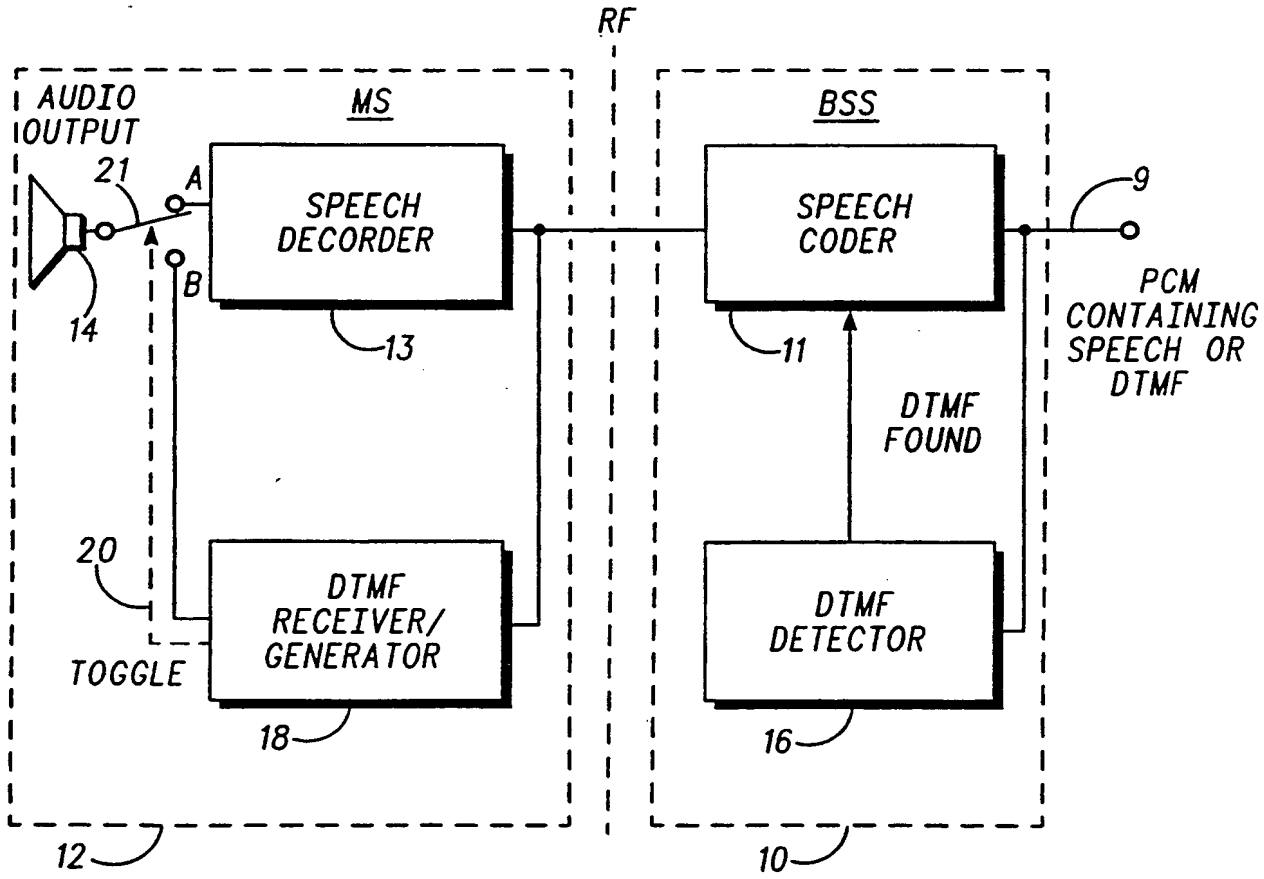
GB 2 290 005 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.



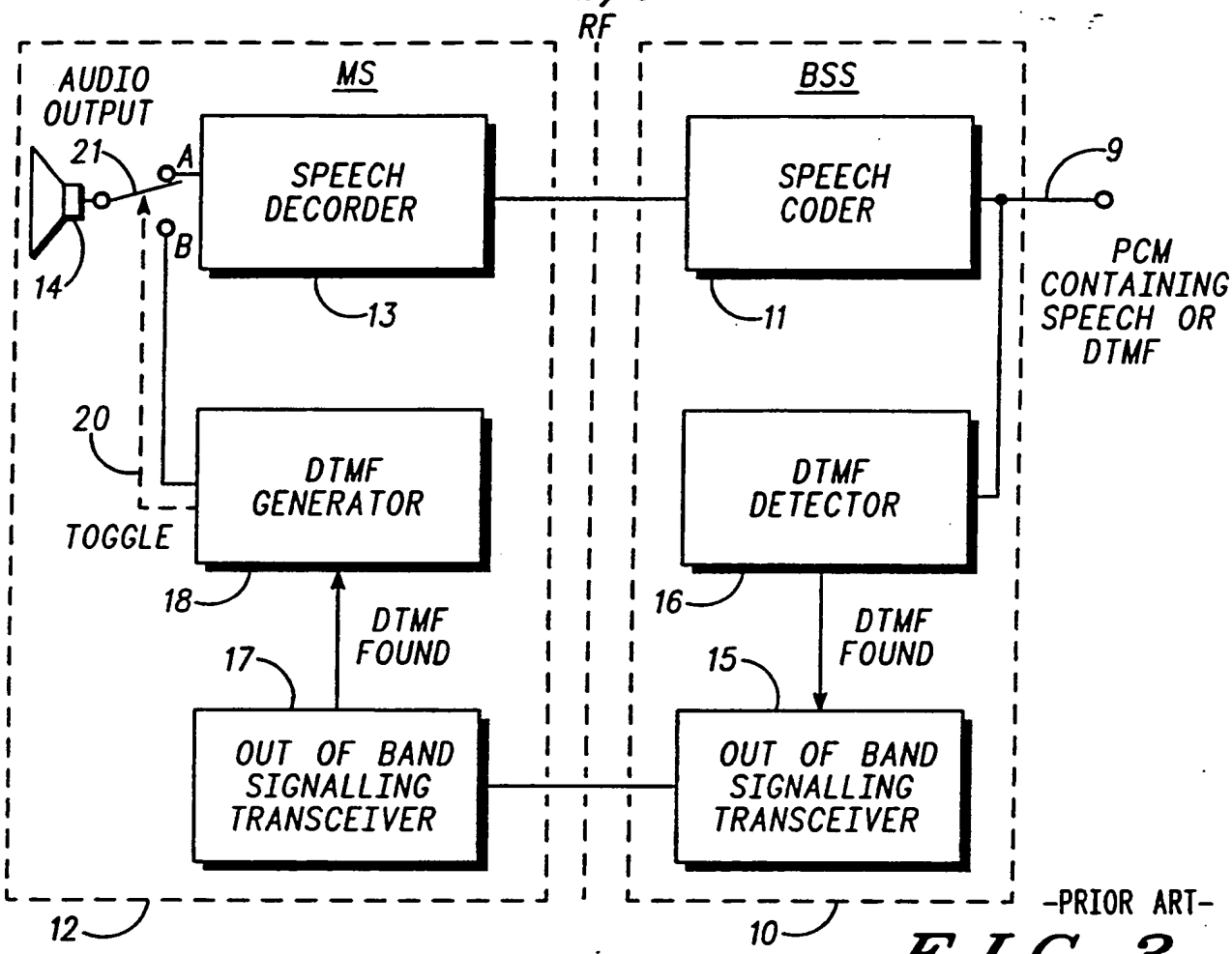
-PRIOR ART-

FIG.1



-PRIOR ART-

FIG.2



-PRIOR ART-

FIG. 3

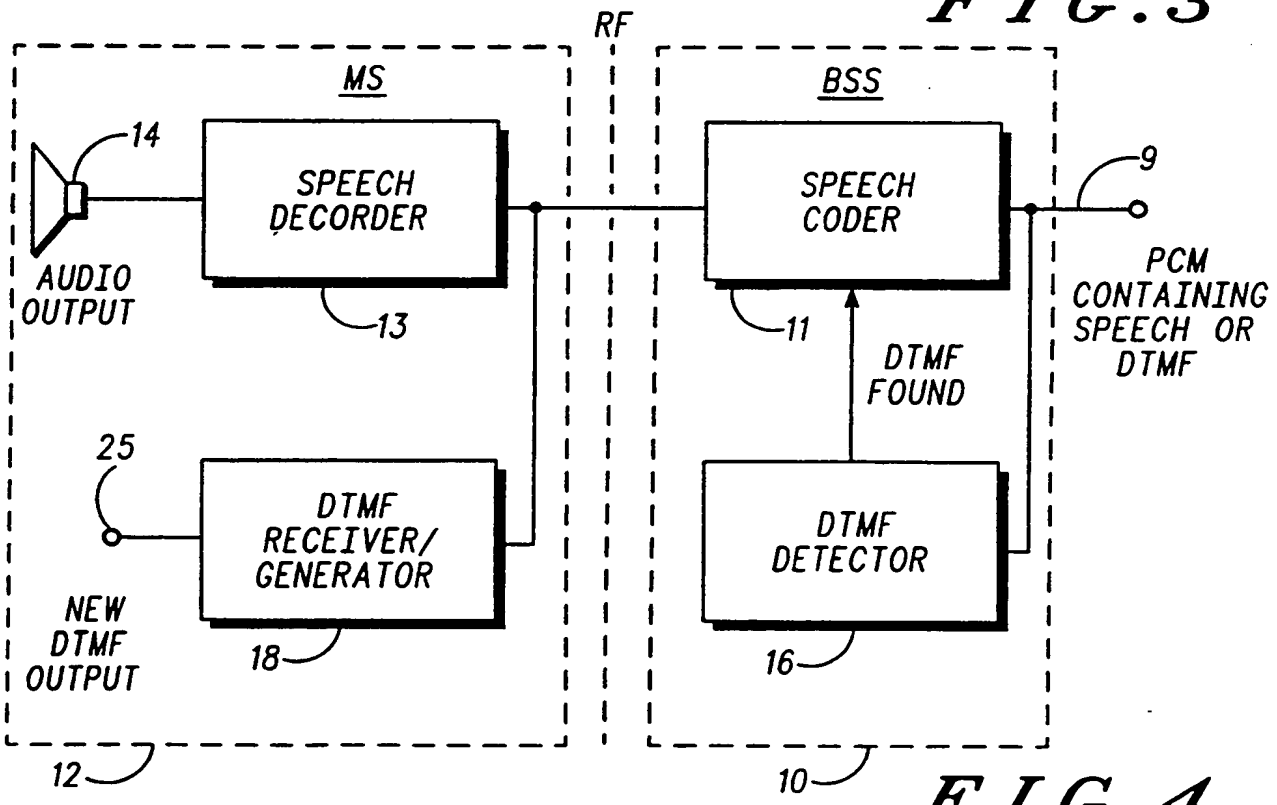


FIG. 4

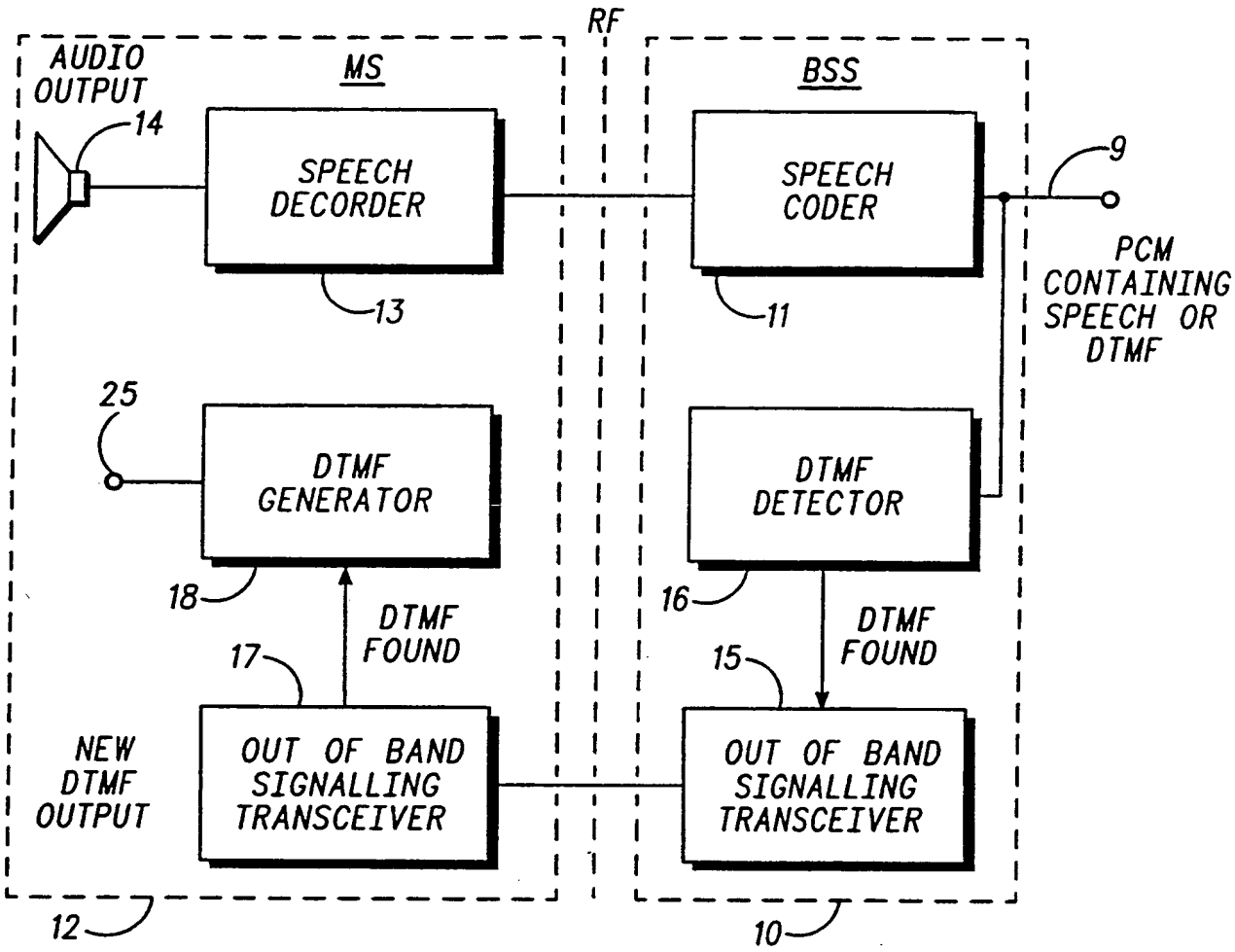


FIG. 5

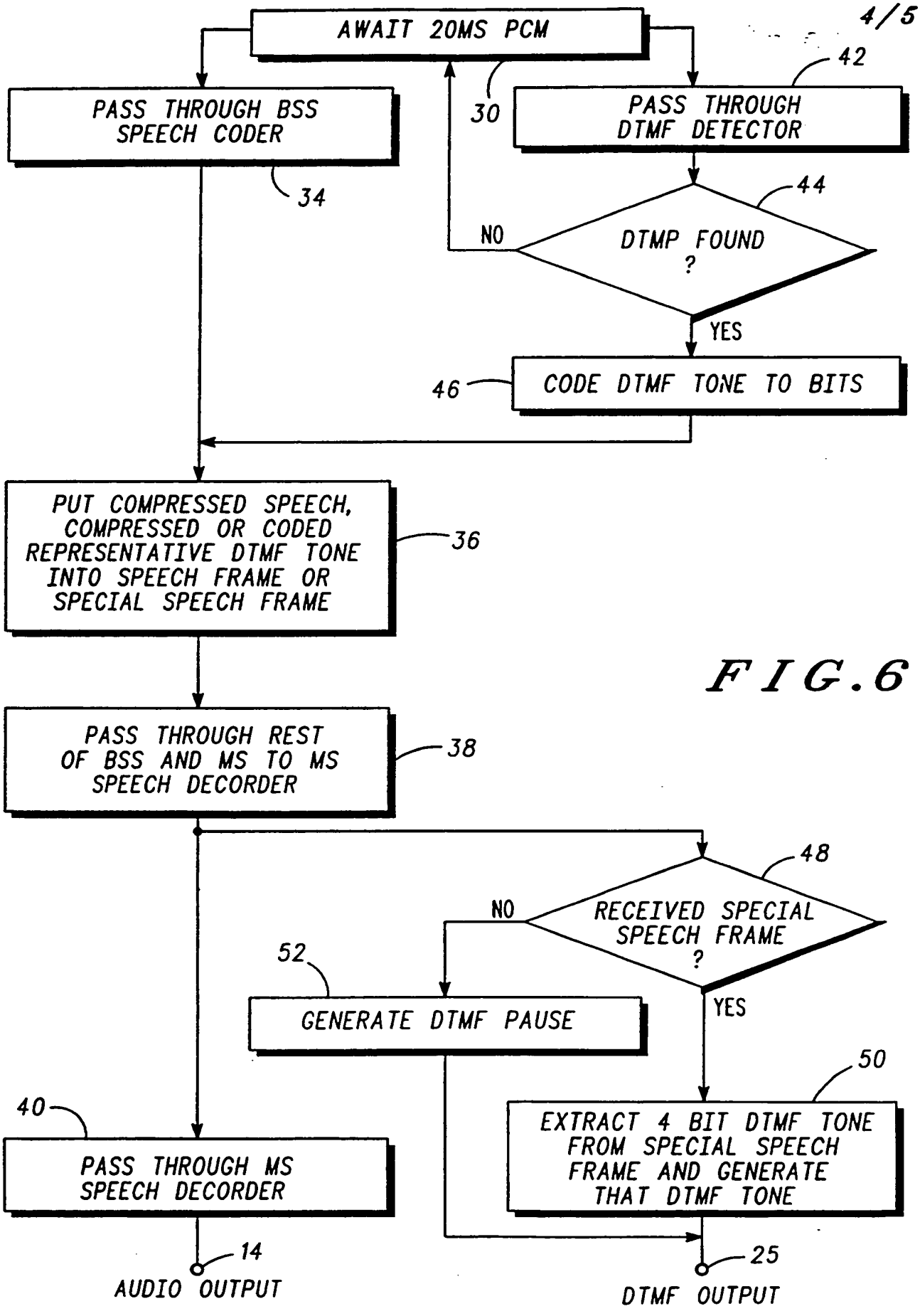

AWAIT 20MS PCM
30
PASS THROUGH BSS SPEECH CODER
34
PASS THROUGH DTMF DETECTOR
42
DTMP FOUND ?
44
NO
YES
CODE DTMF TONE TO BITS
46
PUT COMPRESSED SPEECH, COMPRESSED OR CODED REPRESENTATIVE DTMF TONE INTO SPEECH FRAME OR SPECIAL SPEECH FRAME
36
PASS THROUGH REST OF BSS AND MS TO MS SPEECH DECORDER
38
RECEIVED SPECIAL SPEECH FRAME ?
48
NO
YES
GENERATE DTMF PAUSE
52
EXTRACT 4 BIT DTMF TONE FROM SPECIAL SPEECH FRAME AND GENERATE THAT DTMF TONE
50
PASS THROUGH MS SPEECH DECORDER
40
AUDIO OUTPUT
14
DTMF OUTPUT
25

FIG.6

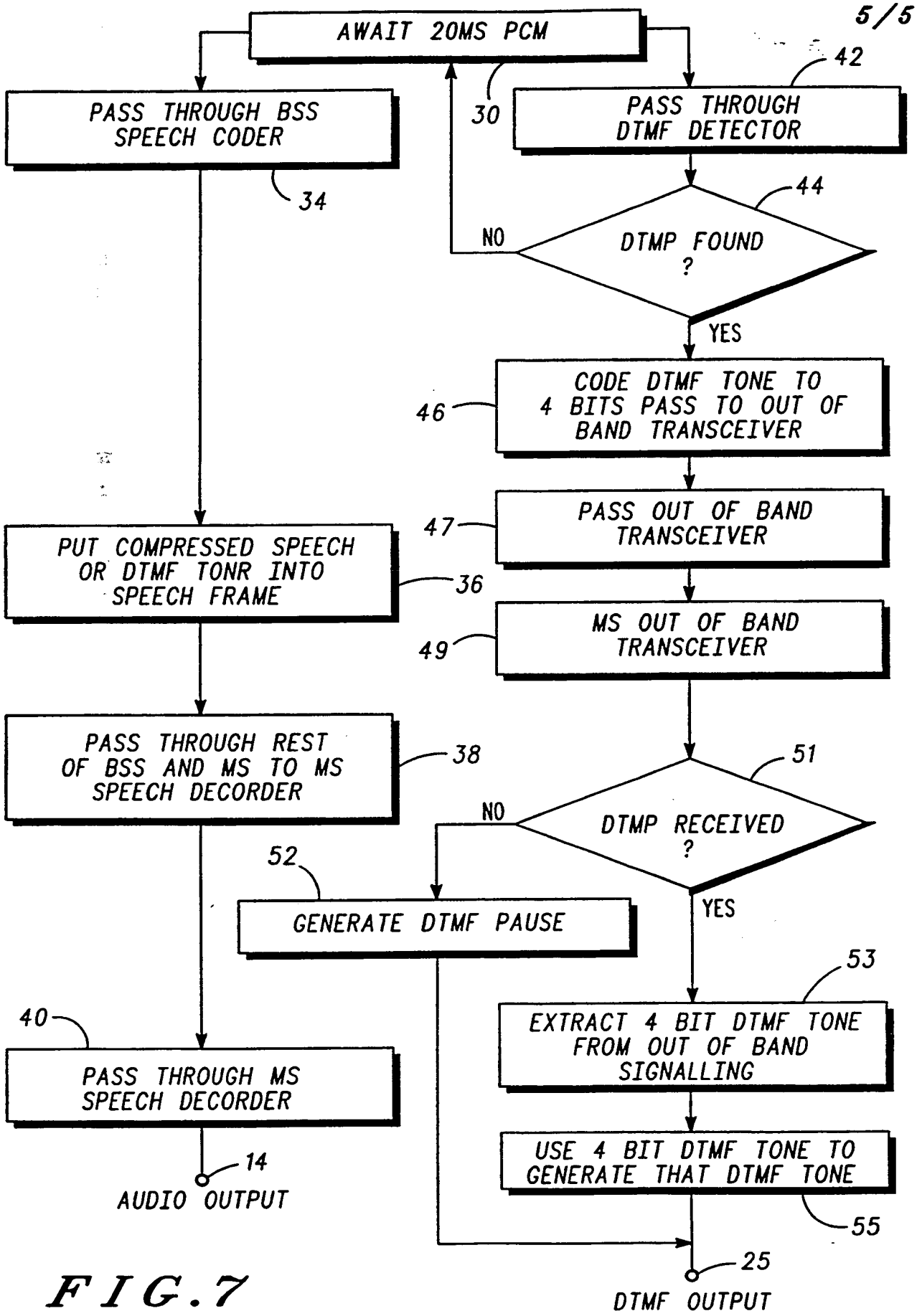


FIG.7

COMMUNICATIONS SYSTEM

Field of the Invention

This invention relates in general to communications systems, and more particularly to a method and an apparatus for outputting DTMF tones in a communications systems.

Background to the Invention

Dual-tone, multiple frequency (DTMF) refers to an access method in a communications system where certain tones represented by certain frequencies are used to indicate particular numbers or functions. Particularly, in a public switch telephone network (PSTN) DTMF can be used for dialling purposes at the start of a call and also for sending information to the called party during a call (e.g., for controlling voice mail boxes, answering machines). DTMF may even be used at the end of the call to indicate that another call of a certain nature is to be made.

Similar support is required for digital cellular systems. For example, support of auto-answering mobile stations is required especially those with note pad facilities which have particular importance to car mobile stations where road safety is imperative.

DTMF is specified in CCITT recommendations Q.23 and Q.24 and ideally a digital cellular communications system such as GSM should conform to such recommendations in order to allow good inter-working with DTMF receiving equipment.

There is no present GSM specification that defines how a DTMF tone must be accommodated in the GSM system in the downlink direction, downlink being from a base station to a mobile station. However, various methods have been put forward to support such a downlink DTMF tone.

Referring to FIG. 1, a DTMF signal may be treated as if it were normal speech and passed directly to a speech coder 11 in a base station system (BSS) 10 and received as if it were normal speech in a speech decoder 13 of a mobile station (MS) 12. Such a transparent method treats all PCM signals, including both speech and DTMF signals, the same. The PCM signals are inputted at an input 9 to the speech coder 11 in BSS 10 and

passed to the speech decoder 13 of the MS 12 without differentiating between signal types.

Referring to FIG. 2, an inband downlink DTMF signalling scheme includes the use of a DTMF detector 16 in the speech coder 11 in the BSS 10 and the use of special speech frames to send DTMF when the DTMF detector has found a tone. In the MS 12, the speech decoder 13 reacts to the receipt of such special speech frames to regenerate the DTMF tone in a DTMF receiver/generator 18 through the normal speech output path or loudspeaker 14. The special speech frame contains a particular four bit pattern for each DTMF tone that is distinct from the other 15 DTMF tones and a signal that indicates how long the tone is to be generated for, such as for at least 20ms or the last 15 ms of frame. In practice, the PCM samples are passed to both speech coder 11 and the DTMF detector 16 in the BSS 10. If the DTMF detector 16 finds a DTMF tone, it instructs the speech coder 11 to transmit a special speech frame accordingly. In the MS 12 the received data is sent to both speech decoder 13 and a DTMF receiver/generator 18. When a special speech frame is found by the DTMF receiver/generator 18, it toggles a switch 21 from A to B and outputs the necessary DTMF tone. In normal speech the switch 21 is in position A.

Referring to FIG. 3, an out of band downlink DTMF signalling scheme employs the use of the DTMF detector 16 described in reference to FIG. 2 but the scheme of FIG. 3 sends the four bit pattern via a signalling channel, such as the FACCH, using out of band signalling transceivers 15, 17 in the BSS 10 and MS 12, respectively. Alternatively, this scheme may directly send the four bit pattern via a signalling channel such as FACCH. The former will be that case if the DTMF tone was generated outside the mobile switching centre (MSC) and the later may be the case if it was generated inside the MSC. In practice, the PCM samples are passed to both speech coder 11 and a DTMF detector 16 in the BSS 10. If the DTMF detector 16 finds a DTMF tone, it instructs the out of band signalling transceiver 15 to send that tone via a the signalling channel. The matched out of band transceiver 17 in the MS will pick up this tone from the signalling channel and send it to the DTMF generator 18 in the MS. The DTMF generator 18 toggles the switch 21 from A to B and outputs the necessary DTMF tone. In normal speech the switch is in position A.

The problems with each of the above schemes are as follows. In the transparent scheme of FIG. 1, it has been found that a full rate speech

codec (coder/decoder combination module) can pass DTMF tones through with allowable degradation under certain circumstances but that a half rate speech codec cannot. In both cases, neither result conforms to CCITT requirements.

The problems of the inband scheme of FIG. 2 are that the speech codec works on a 20 ms frames basis whilst the DTMF detector 16 needs at least 60 ms (40 ms for tone plus 20 ms for allowable pause during tone) before it can detect a tone, according to CCITT specifications (Q.24). This means either a DTMF tone is sent twice (once via the normal speech path using normal speech frames and once via the normal speech path through the special speech frame after the DTMF detector 16 has found a tone) or that the speech path must exhibit a delay in the order of 60 ms plus in order to await the possible detection of a tone. In the case where two tones are transmitted, two tones will be received. The first tone received could be the same as the desired tone or corrupted to the extent that it looks like some other tone. Neither of these results is desirable as the DTMF receiving equipment could perform unexpectedly.

Delaying the speech means a significant degradation to all speech calls and even the inter-operability of echo cancellers, the delay is quoted as 60 ms plus as the alignment of the tone which is not related to the alignment of the 20 ms speech frames that the speech coder handles. Thus, in the worst case a delay of 80 ms is needed.

It has been suggested that a DTMF detector could be made such that it could respond to tones after say 5 ms instead of 40 to 60 ms. Such a DTMF detector has not been specified or even feasible and will certainly mean non-conformance to CCITT DTMF standards.

The out of band scheme of FIG. 3 shares the same problems as the inband scheme, e.g., an intolerable delay or double tone transmission/generation problem. Moreover, the out of band scheme has the further problem that the FACCH channel affects both directions (uplink and downlink) and the inability to control the duration of the tone. Also, if the DTMF detector 16 is located at the BSS transcoder 11, new functionality is required to connect the transcoder with the signalling system.

Thus, it is desirable to have an apparatus and a method for reliably outputting DTMF tones from a mobile station operating in a digital cellular

communications system. It is also desirable to have an apparatus and method for outputting DTMF tones in conformance with CCITT standards.

Summary of the Invention

According to the present invention a communications system is provided comprising a base station and a mobile station arranged for communication including transmission of DTMF signals wherein the mobile station includes a DTMF output separate from an audio output.

According to the present invention a method is provided for outputting DTMF tones at a mobile station including outputting the DTMF tones at a mobile station's separate second DTMF output.

In an alternate embodiment, a method is provided for outputting DTMF tones at a mobile station in a communications system including detecting a DTMF tone at a base station, converting the DTMF tone into a DTMF coded signal, sending the DTMF coded signal to the mobile station, converting the received DTMF coded signal to the representative DTMF tone at the mobile station, and outputting the DTMF tone at a separate DTMF output.

Brief Description of the Drawing

FIG. 1 shows prior art transparent downlink DTMF transmission.

FIG. 2 show prior art inband downlink DTMF transmission.

FIG. 3 shows prior art out of band DTMF transmission.

FIG. 4 shows a preferred embodiment according to the present invention.

FIG. 5 shows an alternate embodiment of the present invention.

FIG. 6 shows a flow chart for a method according to the preferred embodiment of the present invention.

FIG. 7 shows a flow chart for a method according to an alternate embodiment of the present invention.

Detailed Description of the Preferred Embodiment

Referring to FIG. 4, for inband downlink transmission, a block diagram shows that the PCM input 9 is sent to the speech coder 11 and the DTMF detector 16 of the BSS 10. A standard implementation of a DTMF detector may be used. If DTMF tones are detected then special speech frames are used to send representative DTMF signals to the MS 12. In the

MS 12, the speech decoder 13 reacts to the receipt of such special speech frames to regenerate the DTMF tone in the DTMF receiver/generator 18 and outputted at a separate output 25 from the audio output 14.

Similarly, referring to FIG. 5, for out of band downlink transmission, a PCM input 9 is sent to the speech coder 11 and the DTMF detector 16. A standard implementation of a DTMF detector may be used. If DTMF tones are detected then an out of band signalling transceiver 15 sends representative DTMF signals via a signalling channel to the MS. In the MS 12, an out of band signalling transceiver 17 receives the representative DTMF signals and sends the representative DTMF signals to the DTMF generator 18 to regenerate the DTMF tones and outputs the DTMF tones at a separate output 25 from the audio output 14.

FIG. 6 is a flow chart describing a method for the embodiment of the present invention described in FIG. 4. The BSS awaits 20 ms PCM signals as in step 30. The PCM signals are inputted to the speech coder of the BSS as in step 34. The speech coder then compresses the PCM signals and puts them into a speech frame as in step 36. The compressed signals are passed through the rest of the BSS and transmitted to the MS where they are sent to the speech decoder as in step 38. The compressed signals are then processed through the speech decoder of the MS as in step 40 and outputted at the audio output 14.

The PCM signals inputted at step 30 are also processed by a DTMF detector as in step 42. If DTMF tones are found, as in step 44, they are coded to a four bit representative DTMF signal at the speech coder as in step 46 and put into a special speech frame in step 36. The DTMF coded signals are passed through the rest of the BSS and to the MS to the MS speech decoder as in step 38. If the speech coder receives a special speech frame as in step 48 a DTMF receiver/generator extracts the four bit DTMF tone from the special speech frame and generates the DTMF tone as in step 50. The DTMF tone is then outputted at a separate DTMF output 25. If in step 48 there is no special speech frame received, a DTMF pause is generated as in step 52 and outputted at DTMF output 25.

FIG. 7 is a flow chart describing a method for the alternative embodiment of the present invention described in FIG. 5. The BSS awaits 20 ms PCM signals as in step 30. The PCM signals are inputted to the speech coder of the BSS as in step 34. The speech coder then compresses the PCM signals and puts them into a speech frame as in step 36. The

compressed signals are passed through the rest of the BSS and transmitted to the MS where they are sent to the speech decoder as in step 38. The compressed signals are then processed through the speech decoder of the MS as in step 40 and outputted at the audio output 14.

The PCM signals inputted at step 30 are also processed by a DTMF detector as in step 42. If DTMF tones are found, as in step 44, they are coded to a four bit representative DTMF signal at the speech coder as in step 46 and passed to a BSS out of band transceiver as in step 47. The DTMF coded signal is then passed through the rest of the BSS and transmitted to the MS to the MS out of band transceiver as in step 49. If DTMF coded signals are received as in step 51 the DTMF generator extracts the DTMF tone and generates the tone as in steps 53 and 55. The DTMF tone is then outputted at DTMF output 25. If in step 51 there are no DTMF coded signals received, a DTMF pause is generated as in step 52 and outputted at DTMF output 25.

The apparatus and method provides for a separate DTMF output in the MS.

The DTMF detector of the present invention is run in parallel with the speech coder at all time in the BSS. The speech decoder is run in parallel with the DTMF receiver in the MS at all times.

The speech samples that the speech coder analyses are also fed to the DTMF detector. The purpose of the DTMF detector is to continuously look for DTMF tones according to CCITT recommendations. Once found, the DTMF detector will signal the speech coder to send a special speech frame in place of the normal speech frame (i.e., 4 bit code, via inband or out of band).

In the MS, the DTMF receiver will detect the receipt of the special speech frame and pick up the information in it to regenerate the DTMF tone for output to the new DTMF output. The exact nature of the signal that emerges from the new DTMF output in the MS will be conformant with any DTMF receiving equipment that it must operate. It may be a digital signal such as the 4 bit pattern or an analogue signal such as a DTMF tone.

When speech is generated, this is passed through the speech coder and received by the speech decoder as normal. The BSS's DTMF detector will not detect DTMF and so will take no action. The mobile's DTMF

receiver will not detect the receipt of a special speech frame and so generate silence or no signal at the new DTMF output.

The present invention removes the problems associated with receipt of the DTMF tone twice as only one (the good or desired) tone is sent to the DTMF receiving equipment.

The apparatus and method of the present invention allows a standard implementation of a DTMF detector in place of a possible custom lower performance one, including a custom DTMF detector that detects tones after 5ms.

The present invention has been described with reference to a mobile station and a base station system as defined by GSM but is not meant to be limited to such.

The problems with the inband and out of band prior art for downlink DTMF transmission for full and half rate can be overcome by the use of an additional separate outputs for DTMF in the MS. This output is used, instead of the normal audio mobile output, to connect to DTMF receiving equipment at the mobile site. The DTMF detector required in the BSS's speech coder is one that conforms to CCITT performance and so such performance is achieved. Thus an apparatus and method for outputting DTMF tones from a MS in a digital cellular communications system in conformance with CCITT standards is provided.

Claims

1. A communications system comprising a base station and a mobile station arranged for communication including transmission of DTMF signals wherein the mobile station includes a DTMF output separate from an audio output.

2. A mobile station for use in a communications system wherein the mobile station may receive DTMF signals from time to time, the mobile station comprising a DTMF output separate from an audio output.

3. A method for outputting DTMF tones at a mobile station in a communications system where the mobile station includes an audio output and a separate second output, the method comprising the step of:

outputting the DTMF tone at the mobile station's separate second DTMF output.

4. A method for outputting DTMF tones at a mobile station in a communications system including a base station and at least one mobile station where the mobile station includes an audio output and a separate second output, the method comprising the steps of:

receiving the DTMF coded signal from the base station at the mobile station;

converting the received DTMF coded signal to the representative DTMF tone; and

outputting the DTMF tone at the mobile station's separate second DTMF output.

5. A method for outputting DTMF tones at a mobile station in a communications system including a base station and at least one mobile station where the mobile station includes an audio output and a separate second output, the method comprising the steps of:

detecting a DTMF tone at the base station;

converting the DTMF tone into a DTMF coded signal at the base station;

sending the DTMF coded signal to the mobile station;

receiving the DTMF coded signal from the base station at the mobile station;

converting the received DTMF coded signal to the representative DTMF tone; and

outputting the DTMF tone at the mobile station's separate second DTMF output.

6. A method of outputting DTMF tones as substantially as herein described with reference to FIG. 6 of the drawing.

7. A communications system as substantially as herein described with reference to FIG. 4 of the drawing.

Patents Act 1977 Examiner's rep rt to the Comptroller under Section 17 (The Search report)	Application number GB 9410806.5
Relevant Technical Fields (i) UK Cl (Ed.M) H4L (LDSX, LDLX, LECX) H4K (KY4D14P) (ii) Int Cl (Ed.5) H04Q 7/00, 7/02, 7/04 H04M 1/72	Search Examiner B J EDE
	Date of completion of Search 23 AUGUST 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASES: WPI	Documents considered relevant following a search in respect of Claims :- 1-7

Categories of documents

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Y:	Document indicating lack of inventive step if combined with one or more other documents of the same category.	**E:**	Patent document published on or after, but with priority date earlier than, the filing date of the present application.
A:	Document indicating technological background and/or state of the art.	**&:**	Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2262683 A	(BRITISH AEROSPACE) see 12, Figure 2	1-5
X	EP 0332825 A2	(MOTOROLA) see 102, 106 Figure 1 and 306 Figure 4	1-5

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